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Note on the Theorem $e^{ix} = \cos x + i \sin x$.

BY F. FRANKLIN.

The following geometrical demonstration of this theorem is so obvious that it has probably been given before, but I have been unable to find it. Defining e^z as $\lim_{\omega = \infty}\left(1 + \frac{z}{\omega}\right)^\omega$, ω being a positive integer, the geometrical construction for e^{ix} is as follows. From the origin O lay off on the axis of x $OA = 1$, and at A erect a perpendicular $AB = x$; then the point B represents $1 + ix$. Divide AB into ω parts; the first point of division, A_1 say, represents $1 + \frac{ix}{\omega}$. Erect at A_1 a perpendicular A_1A_2, making the triangle OA_1A_2 similar to OAA_1; then A_2 represents $\left(1 + \frac{ix}{\omega}\right)^2$.

Constructing in like manner a similar triangle OA_2A_3, and so on, A_ω will represent $\left(1 + \frac{ix}{\omega}\right)^\omega$. Now let ω tend to infinity; the limit of the broken line $AA_1A_2 \ldots A_\omega$ is an arc of length x in a circle whose radius is 1; hence the limit of A_ω is a point which represents $\cos x + i \sin x$. Therefore

$$e^{ix} = \cos x + i \sin x.$$